Agricultural Research Service

United States Department of Agriculture

THE RUSSIAN WHEAT APHID

First Annual Report of the Agricultural Research Service

U. S. Department of Agriculture

October 1988

Compiled by R. L. Burton, ARS Technical Coordinator

Plant Science Research Laboratory

Stillwater, Oklahoma

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Introduction

The Russian wheat aphid, *Diuraphis noxia* Mordvilko, hereafter referred to as RWA, is a newly introduced aphid pest in the United States. The insect was first detected in the Texas Panhandle in March 1986. During the two and a half years since that time the pest has spread to almost all the small grain growing areas of the western states (see map on page 3): currently 15 U.S. states and 2 Canadian provinces. The insect migrates on prevailing winds, the same method it used to invade the United States from Mexico. The Plant Science Research Laboratory, Stillwater, OK, was the first to identify the pest as the RWA. Stillwater scientists were aware of the pest's importance in other parts of the world, especially South Africa (Walters, 1984), and had accumulated information concerning the pest. This information was distributed for use by the industry until research results from the United States became available. This was extremely important considering that the pest moved rapidly across the Great Plains during that first year, causing considerable damage before any information could be obtained.

The RWA is now a serious threat to the wheat and barley industry in the United States. Damage estimates for 1987 indicate that $53 million was lost due to the direct damage and control costs. Since the pest had not had time to migrate to all the areas and states it now infests, this estimate reflects damage inflicted primarily in the central and southern Great Plains; much of the damage, $26 million, was reported from Colorado alone. Damage estimates for 1988 are not yet available, but the general consensus is that damage will exceed 1987 estimates.

Damage inflicted by the RWA is expressed in the plant by several symptoms including stunting; red, white, and purple streaking; leaf rolling; head trapping; and sterility. Injury to the plant results in yield losses and a reduction in quality (lower test weights). Because of the leaf rolling aspect of damage, the insect is difficult to control. The tightly rolled leaf harbors the pest from exposure to contact chemicals, parasites, predators, pathogens, and weather. Currently, the primary method of control is through systemic insecticides.

Initial ARS research efforts on RWA consisted of a gradual redirection of the plant resistance program at Stillwater, followed by redirections at other locations as the problem became national in scope. Currently 80% of

the cereal insect project at Stillwater is directed toward the RWA, with five scientists in the Wheat and Other Cereal Crops Research Unit spending a portion of their research effort on RWA. At the Northern Grain Insect Research Laboratory, Brookings, SD, three scientists are involved to a limited extent in modeling and predator research. The European Parasite Laboratory, Behoust, France, has directed some of its foreign exploration to include natural enemies of the RWA. Collected materials are sent to the Beneficial Insects Introduction Laboratory, Newark, DE, for quarantine. The Biosystematics Laboratory, Beltsville, MD, has been involved in the aphid taxonomy and distribution. Plant Protection Research, Ithaca, NY, is supporting insect pathology of RWA by providing expertise and colonies of pathogen organisms. For more information, please see specific sections of the following report and the Personnel Section on page 16.

The purpose of this report is to outline the ARS research activities and accomplishments to date related to the RWA. The report will be brief in many respects. Additional detail is available on request.

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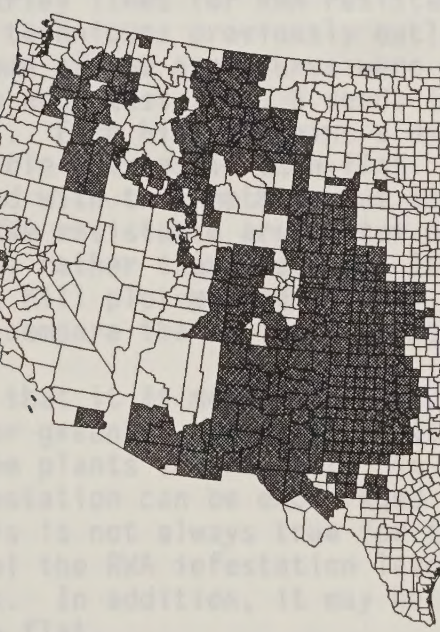
RUSSIAN WHEAT APHID DISTRIBUTION



NOVEMBER 1988

Host Plant Resistance

The host plant resistance and the plant breeding projects work very closely and have primarily the same goal, that is, the release of both wheat and barley germplasms that resist attack of the RWA.

The RWA plant resistance research and plant breeding projects were initiated at the Stillwater laboratory soon after the pest was detected in Texas in 1986. In order to prevent an accidental release to uninfested areas, RWA rearing and testing has been confined to environmental chambers in an isolated building until such time that RWA is detected within the county. RWA has been detected in nearby counties, so it is anticipated that the rearing and testing program may be expanded to the greenhouse soon.

The Stillwater laboratory has a long history of plant resistance research, particularly with the greenbug. Techniques for rearing the RWA and mass screening wheat and barley lines for RWA resistance have, therefore, been adapted from greenbug techniques previously outlined by Starks and Burton (1977). Changes in some of the procedures were necessary. Instead of 10 rows of 20-30 seeds in each test flat, 5 seeds in each of 60 "hills" are planted in a test flat. Each hill contains a different test entry, and there are six susceptible entries in each flat. Some variability within a test line may be missed with this method, but scientists believe that the chances of detecting RWA resistance are better by testing a few plants of a large number of lines rather than testing a large number of plants from only a few lines. The hill plot method appears to work well; however, research is needed to compare the two testing methods.

First indications are that it is more difficult to evaluate germplasm for RWA resistance than for greenbug resistance. It also seems more difficult to uniformly infest the plants in the flat. In the greenbug tests, uniformity of the infestation can be encouraged by gently sprinkling the flats with water. This is not always true for the RWA, however. It may be necessary to control the RWA infestation levels more carefully than is done in greenbug tests. In addition, it may help to plant susceptible "spreader rows" in the flat.

Webster et al. (1987) reported that greenbug-resistant wheat and barley lines are not resistant to the RWA. In addition, the wheat lines PI 137739 (SA 1684) from Iran and PI 262660 (SA 2199) from Russia, which were reported by DuToit (1987) to be resistant in South Africa, have not been resistant to the RWA culture maintained at Stillwater. However, there are now RWA colonies at several other research locations in the United States, and it would be informative to test these lines with these other RWA populations. The Stillwater colony was obtained from a few aphids in Texas in 1986, and has not had other populations mixed in with it. There has been some discussion on whether laboratory colonies should be periodically "rejuvenated" with field populations, and the philosophy of maintaining aphid colonies for plant resistance work needs to be discussed and decisions made.

The plant material tested so far has come from the USDA-ARS National Small Grain Collection or from individual plant breeders. Entries tested from the ARS collection include *Triticum monococcum* (98 lines), *T. dicoccoides* (436 lines), *T. aestivum* (bread wheats) with cultivar names or experiment station designations (3176 lines), the triticale collection (731 lines), and about 5 entries each of 19 *Triticum* species. In barley, 2-5 entries each of 15 *Hordeum* spp. have been tested, and it is planned to test 524 *H. vulgare* lines from countries where the RWA is indigenous. Additionally, a large collection of over 20 wheat species maintained at the Stillwater laboratory is being tested. Materials submitted by plant breeders from at least six other locations have been tested as well.

Probably the most significant finding in the ARS collection to date is the resistance in seven triticale lines. Resistant plants have been saved for crossing and further tests, but how they will work out in the wheat breeding program remains to be seen. Three of the lines are from Dr. Qualset's program in California (CI 81, CI 82, and CI 87) and have 'Snoopy' rye and 'Eskisehir' wheat in their backgrounds. Individual plants of 'Snoopy' and 'Eskisehir' were tested and appear to be susceptible, so the source of resistance is unsure. They are octoploids (2n=56) and are winter habit. The other four lines (PI 386148, PI 386149, PI 386150, and PI 386156) are from Russia and seem to have a higher level of resistance. They are also listed as winter habit, but are reported to be hexaploids. No information in available about the parentage of these Russian lines. There are also some *Triticum tauschii* (Coss.) lines from the Stillwater collection that have been saved for future tests. Since the resistance found to date has been only in relatives of bread wheat and not in bread wheat itself, several plant breeding techniques including embryo rescue, tissue culture, radiation, and possibly use of chemical mutagens will be tried during the process of incorporating RWA resistance into bread wheat.

In the future, efforts will be intensified to locate RWA resistance in barley, which appears to be more susceptible to the RWA than does wheat. In wheat, substantial progress has been made in RWA plant resistance research considering the newness of the program, and we are optimistic about future releases of RWA-resistant wheat germplasm.

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Small Grain Germplasm Development Program

This ARS program is aimed at the development and release of RWA-resistant germplasm. Due to an apparent lack of resistance in any available wheat (*Triticum aestivum*) lines, several accessions of various wheat-related wild species (*Triticum tauschii* and *Triticum umbellulatum*) and some triticales lines (X *Triticosecale*) that appear to have some degree of resistance to the RWA have been selected for evaluation. Interspecific crosses have been made between wheat and these wheat relatives. A major problem that often occurs when making wide crosses such as these is an incompatability that manifests itself through endosperm deterioration and death of the embryo prior to seed maturation. To overcome this problem, a technique called embryo rescue is used. This technique involves excising the immature embryos from developing seeds soon after pollination. Then, after placement on an appropriate culture medium, some of the embryos develop normally.

So far, two different approaches to breeding for RWA resistance have been used, both utilizing the embryo rescue method. The embryos from interspecific crosses involving *T. tauschii* or *T. umbellulatum* were placed on a medium (MS basal medium containing no 2,4-D) that would encourage both root and shoot development and promote the rapid recovery of F1 hybrid plants. The embryos from the wheat X triticale were placed on a medium that would induce callus formation (MS basal medium containing 4.5 M 2,4-D). If the RWA resistance from the triticale is contributed by the rye genome, then an extended period of time in callus should result in an increased number of the desired chromosomal translocations. Hybrid plants that then develop from the callus would be expected to include a greater proportion of individuals with a piece of a rye chromosome incorporated into their wheat genome. If a translocation involving a chromosome carring resistance genes occurred, this would greatly facilitate the incorporation of RWA resistance into more agronomically desirable wheat lines. On the other hand, if the resistance from the triticale is contributed from the wheat genome, natural crossing over will occur and considerable time will be saved in the breeding program. The resistant materials crossed to wheat will be tested soon. At that time it will be possible to determine just how the resistance reacts in a wheat background.

Alternate Hosts for Russian Wheat Aphid

The economic importance of the RWA on barley and wheat will depend, in part, on its ability to utilize plant species as alternate and oversummering hosts. Currently, many warm- and cool-season grasses are being recommended by Land Grant Colleges and the USDA-Soil Conservation Service for more efficient use of rangelands, for land reclamation projects, and for prevention of soil erosion. By 1990, over 40 million acres will be taken out of crop production and planted to grasses under the Conservation Reserve Program (CRP). Most CRP acres are located in the wheat and barley production areas of the United States, i.e., the Southern Plains, Northern Plains, and Mountain regions, where large acreages of highly erodible marginal croplands exist (U.S. Dep. Agric., Office of Information, 1988). Few, if any of the grass species being utilized in reseeding programs have ever been evaluated for their host suitability and harboring of major grain crop pests.

The Stillwater laboratory conducted a study to determine survival and reproduction of the RWA on warm- and cool-season grasses, legumes, and forbs. Most of the seed used for study were obtained from Plant Materials Centers, USDA-SCS. Additional seed studied was obtained from stock maintained at the Stillwater laboratory and the Oklahoma Agricultural Experiment Station. Host suitability was determined on plants, 2-4 weeks old, infested with 10 late instar RWA. After 14 days, the aphids and their surviving progeny were removed from the plants and counted.

The tabular results are presented elsewhere (Kindler and Springer, 1988). The RWA survived on all but 1 of 48 cool-season grass species, about 50% of 32 warm-season grass species, and none of the 27 legumes or 17 forbs. Jointed goatgrass (*Triticum cylindricum*) was the most suitable host, followed by barley, European dunegrass (*Elymus arenarius*), and little barley (*Hordeum pusillum*). The RWA survived equally well on several cool-season grass species when compared with wheat. Warm-season grasses compared with wheat were poor hosts for the RWA. Many cool-season grasses were as preferred or more so than the most preferred warm-season grass species. The importance of the RWA in North American has increased because it can survive on a broad host range of cool- and warm-season grass species that commonly occur throughout the barley and wheat production areas. Grasses offer a variety of alternate habitats that could act as reservoirs for this important crop pest.

Biocontrol Program

A committee was selected to prepare a research plan for a biological control program for RWA in the United States. The committee consisted of Ray Moore, Roger Fuester, Richard Humber, Tad Poprawski, Norman Elliott, and Robert Burton. Following the International Congress of Entomology, Vancouver, British Columbia, an informational meeting was held to encourage input into the research plan from sources outside ARS; about forty people attended. The committee then met for several days and prepared a draft of the research plan. The draft is now in the process of being revised.

Stillwater, OK

The biocontrol program at Stillwater has only been established for a short period of time. David Reed, the program coordinator, joined the staff on October 6, 1988. Prior to Dr. Reed's arrival, Benjamin Puttler from the Columbia, MO, laboratory came to Stillwater on TDY for 60 days to handle the biocontrol agents from foreign collections. The Stillwater laboratory started to receive imported parasites (via the quarantine laboratory at Newark, DE) at various intervals from 8/17 to 9/22/88. Since the RWA is the primary target organism of these parasites, it was used to initiate cultures on infested barley seedlings or on bouquets of leaves from the same plant. *Aphidius* sp. and *Ephedrus plagiator* produced a small number of an F1 generation, almost exclusively males due to the parent females not being mated, which results in all male progeny. Observations in the sleeve cage units used indicated that although the parasites were attracted to the RWA they primarily searched for hosts exposed on the leaves. In contrast, the *Aphelinus* sp. searched for both exposed aphids and those developing in the leaf curl, the primary niche and preferred site for RWA development. An F1 generation was produced, but again, lack of mating resulted in all male progeny. Laboratory observations to date point to *Aphelinus* sp. as having a better potential as a biocontrol agent because of its ability to search the niche in which the RWA develops. It also completes its life cycle in about 12 days at 22-25°C rather than 14 days for *Aphidius* sp. and *E. plagiator*. *Praon volucre* was the least attracted to the RWA, and no progeny were produced.

Currently Stillwater has one exotic parasite in culture in the laboratory. This is an *Aphidius* sp., possibly *rhopalosiphi*, collected from the RWA at Beyparazi, Turkey, and received in Stillwater on September 22, 1988. As of October 31, F3 generation adults had emerged. Development time was about 11-13 days at lab temperatures. More than 50% of the adults were females, indicating that this species has been established in the lab.

The parasite rearing program at Stillwater is still in the exploratory phase. Scientists are attempting to exercise a degree of selectivity by concentrating on those species known to have been reared from the RWA.

The mating problem and host switching for rearing the parasites (RWA --> greenbug --> RWA) may be factors that are contributing to the establishment of viable cultures of the imported parasites.

An *Aphelinus* sp. (*asychis*?) was reared from a greenhouse infestation of greenbugs and oat bird-cherry aphids found infesting small grain seedlings at Stillwater. Adults were exposed to the RWA, and it was found to be an acceptable host for development of the parasite. As of October 1988, a viable culture was being maintained in the lab at 22-25°C with a development time of about 12 days (egg to adult). Another *Aphelinus* sp. (*varipes*?) was observed in greenbug infestions on sorghum in Oklahoma and Nebraska. It appears similar to the introduced *Aphelinus* mentioned earlier, but as yet it has not been determined if it will parasitize and develop in the RWA. Surveys should probably be conducted to see if these two naturally occurring *Aphelinus* accept the RWA as a host in the field. Both species have siblings in the Old World, with the RWA as a known host.

Behoust, France

Exploration for biological control agents for RWA was conducted by the European Parasite Laboratory (EPL). The CAB International Institute of Biological Control (CIBC) cooperated. Exploration into Russia was not possible this year, consequently Turkey was selected as the initial country to survey because of its close proximity to the Crimea, an area in Russia to which *D. noxia* is endemic. Three survey trips were made by EPL (5/9-6/1, 6/14-6/19, 9/16-9/28) and one by CIBC (5/22-6/2) in wheat and barley fields encompassing areas in all cardinal directions from Ankara. In sampled fields *D. noxia* was found sporadically and in low numbers as determined from sweep and visual inspection of plants. *Schizaphis graminum* (greenbug), *Acyrthosiphon (Metopolophium) dirhodum* (rose-grass aphid), and *Rhopalosiphum maidis* (corn leaf aphid) also occurred in small numbers. *Macrosiphum (Sitobion) avenae* (English grain aphid), *Macrosiphum (Sitobion) fragariae* (blackberry-cereal aphid), and *Sipha (Rungsia) elegans* were more common. Parasites, predators, and pathogens found associated with or reared and isolated from these aphids are listed.

Parasites	Host
Aphidiidae	
Aphidius sp.	RWA, cereal aphids
A. uzbekistanicus	Cereal aphids
A. matricariae	RWA
A. rhopalosiphi	RWA
Ephedrus plagiator	RWA, cereal aphids
Aphelinidae	
Aphelinus sp.	RWA
A. varipes	RWA
Predators	
Coccinellidae	
Adonia varigata	RWA
Thea 22-punctata	RWA
Propylea 14-punctata	RWA
Scymnus sp.	RWA
S. ater	Greenbug
S. interruptus	Greenbug
Chamaeyiidae	
Leucopis sp.	RWA
Pathogens	
Entomophthorales	
Zoophthora radicans	RWA
Erynia neoaphidis	RWA, cereal aphids
Eniomphthora planchoniana	RWA
Neozygites fresenii	RWA, cereal aphids

EPL also collected parasites, predators, and entomopathogenic fungi of the greenbug in southern France, primarily because of the apparent broad host range of the entomophagous species in cereal grain ecosystems. Similar species of predators were encountered as those found in assocation with the RWA in Turkey. Of the parasites *Aphidius* sp., *Ephedrus plagiator*, *Praon volucre*, and *P. gallecum*, only the first three species were reared from Turkish RWA.

All parasite material obtained as a result of exploration, irrespective of the host from which it emerged, was propagated at EPL on the greenbug prior to importation.

Brookings, SD

Imported coccinellids obtained from overseas exploration for the RWA natural enemies are being received and reared at the NGIRL. Currently, two species are in culture (*Scymnus frontalis* and *Hippodamia variegata*), in addition to the native coccinellid *Hippodamia convergens*. Current plans are to supply a limited number of cooperators with imported coccinellids for release into RWA infested areas, and to undertake basic research and evaluation of promising natural enemies.

Predators are known to reduce populations of several cereal aphids, but the magnitude of their effect on RWA populations is not yet known. Evaluating the impact of predators on RWA populations and incorporating information on natural enemies into decision-making systems for cereal aphid management will be facilitated by development of time-efficient, precise, and accurate methods for sampling their populations. The current objective is to develop time-efficient methods for sampling coccinellid populations in small grains. The experimental method involves the use of removal sampling to obtain absolute estimates of population density. Relative estimates of population density (sweepnet and visual sampling) are taken simultaneously, along with environmental measurements. Adjustment factors are used to transform relative estimates into absolute density estimates. Results from 1988 indicate that sweepnet sampling yields unbiased estimates of relative abundances of all species of coccinellids occurring in small grain fields in South Dakota, while visual sampling does not. Sweepnet sampling is also more time efficient than visual sampling for obtaining density estimates.

Newark, DE

Shipments from EPL were received in the quarantine facilities at the Newark laboratory beginning 8/4/88, comprising a total of 38 shipments of 6 parasite and 9 predator species. Highest mortality during shipment occurred with *Aphidius* spp. and *Aphelinus varipes* from Turkey.

Outgoing shipments from Newark to the Stillwater laboratory and cooperators in other states totaled 24, involving 8 species (5 parasite, 3 predator), with a total of 914 specimens shipped.

Ithaca, NY

The laboratory at Ithaca continues to provide potentially pathogenic organisms to requesters. The lab will play a key role in the pathology program for RWA at the Stillwater lab by providing candidate pathogen colonies and expertise in culture methods and evaluation techniques.

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RWA/Plant Interaction

Stillwater, OK

The visible symptoms of RWA damage were listed in the introduction of this report. These are symptoms that can be observed under field conditions and are the result of severe physiological dysfunction and structural alterations induced by RWA feeding. Using greenhouse-developed plant cultural techniques and aphids of controlled age and number, feeding-caused dysfunctions to wheat seedlings have been characterized and quantified.

One of the more pronounced effects of RWA feeding on wheat seedlings is a significant reduction of total effective leaf area. Total photosynthetic leaf area can be reduced by over 50% following infestation by the RWA. This reduction is manifested by several factors. One of the factors, probably the main one, is the tightly rolled condition of new leaves, caused by the feeding, leaving only a portion of the leaf surface area exposed. The number of tillers is also reduced, thus reducing the total number of leaves. Moreover, leaves are shorter on damaged plants. The combination of the later two factors are manifested in the reduction in total shoot biomass. Reduced total leaf area. combined with chlorotic plant responses, would have a significant impact on the plant's ability to photosynthesize at optimal levels.

Although the RWA only feed on the aerial portions of the plant, the below-ground parts of the wheat seedling are also affected. The combined length of all the roots are reduced at least 25%, and perhaps even more under more extreme feeding pressure. Because of the reduction in total root length, total root biomass (root dry weight) is severely reduced. More work on the effects of feeding on the root system is needed. A reduced root system means that the function of water/mineral uptake is surely affected.

The physiological characterization of plant damage caused by RWA feeding is imperative to the understanding of how the RWA causes economic losses in the field. Countering these effects with certain cultural and management practices may be possible. Also, these feeding effects eventually may be used in the host plant resistant program to improve techniques for the evaluation of resistant material.

Brookings, SD

The influence of RWA on the inhibition of root growth of seedling winter wheat was tested in the greenhouse using hydroponic techniques. The RWA (5-15 aphids/plant) markedly reduced root growth of seedling plants during a 7-day feeding period. The root mass of a subset of plants was mechanically reduced by 50%, and treated and control plants were planted in soil to determine reductions in yield at harvest caused by root inhibition during the seedling stage. This portion of the test was

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inconclusive because of problems obtaining consistent vernalization of plants. The test is being repeated again in an attempt to obtain conclusive results.

The influence of RWA infestation on osmotic adjustment and accumulation of glycinebetaine and proline in water-stressed barley was investigated. Leaves from plants infested with aphids contained lower levels of chlorophyll and higher levels of amino-N and total-N than leaves from uninfested plants. When water was withheld for seven days after insect infestation, the relative water content of uninfested plants remained at about 0.95 for the first four days, followed by a steady drop to about 0.77, while the relative water content of infested plants dropped steadily from 0.95 to 0.60. Analysis of glycinebetaine and proline levels at the end of the water stress period indicated that leaves of previously infested plants accumulated lower levels of these solutes than leaves from uninfested plants. Upon alleviation of water stress, plants previously infested with aphids showed little increase in dry weight, while uninfested plants showed large increases. It was concluded that the loss of chloroplast function, and not the removal of assimilates, limited the capacity of leaves to adjust to water stress in RWA-damaged plants.

The effect on yield of winter wheat of low population densities of RWA feeding for an extended period of time was tested under controlled conditions in environmental chambers. Aphid densities of 2, 8, 10, 12, and 16 aphids per plant fed for 30 days at 12.8°C were employed. After the 30-day feeding period, plants were vernalized and grown to maturity, at which time components of yield were measured. Yields of plants infested with 10, 12, and 16 aphids were significantly lower than those of uninfested controls. Yields of plants infested with 2, 4, and 8 aphids were not significantly different from controls.

Five planting times and 15 foliar insecticides were employed in a trial on winter wheat during the fall of 1988. The initial number of RWA in plots at the time foliars were applied was about 75 per plant. Results of the test will be available in the near future.

Simulation Modeling

At Brookings, SD, a computer simulation model incorporating current knowledge of the effects of temperature and age on RWA population dynamics was developed. The model was written in Fortran 77 and implemented on an IBM-PC AT. The model contains provisions for quantitatively describing effects of food quality (host plant age, host plant variety, etc.) and RWA population density on RWA immature development, survival, natality, and morph determination. Adequate data are not yet available to provide useful parameterization of functions describing the above mentioned processes, but studies currently underway at the NGIRL should provide some of the necessary data. The model also contains subroutines to describe the influence of natural enemies on RWA population dynamics (at present these are only "dummy" subroutines) and immigration, and can be linked to models of host plant growth. Currently, a simple model of spring wheat growth is linked to the RWA simulation model. If funds permit, validation studies will be attempted once the model is adequately parameterized.

During the next year, the model will be extended to include several additional economically important cereal aphid species. Because cereal aphids generally occur in mixed species populations in the field, and because their dynamics are linked via interspecies interactions, host plant responses, and natural enemy responses, a multispecies approach may be necessary for a comprehensive systems analysis of the RWA/small grain system.

Biosystematics

During the past year, Dr. Manya B. Stoetzel, Beltsville, MD, continued to provide identifications of or verifications for *D. noxia* and initiated a biosystematic research project on species in and related to *Diuraphis*. Over 100 slides were made of specimens of *D. noxia* from the United States and from South Africa and of specimens of *D. mexicana* from Mexico. Many more samples from these and other populations will be needed for the morphometric analyses now planned. Special FY88 ARS funding made possible: 1) the upgrade of a Wang PC to a Wang PC280-3 which is IBM compatible so that all software packages of interest are now compatible; 2) the purchase of a ZIDAS digital analysis system; 3) a contract for 24 pen-and-ink drawings of winged and wingless females of four *Diuraphis* species; and 4) support for rearing of specimens needed for morphometric studies. Reprint requests for Dr. Stoetzel's 1987 article, "Information on and Identification of *Diuraphis noxia* (Homoptera: Aphididae) and Other Aphid Species Colonizing Leaves of Wheat and Barley in the United States," totaled 197 and were received from workers in the United States and 15 foreign countries.

Dr. Stoetzel prepared an invited talk "*Diuraphis noxia*, the Russian Wheat Aphid: What We Know and What We Need to Find Out" presented October 3, 1988, as part of the symposium "New Pests and Their Routes of Entry" during the 1988 Eastern Branch Meeting, Entomological Society of America, Syracuse, NY.

During 1989, additional material of *D. noxia* will be collected from the United States, Canada, Mexico, Europe, and South Africa. Attempts will be made to collect *D. nodulus* (Richards) in British Columbia. Material of related species will also be collected and mounted, and morphometric studies will begin.

Personnel

RWA Project	Personnel
Host Plant Resistance	Stillwater, OK James Webster, Research Entomologist Keith Mirkes, Agrl. Res. Techncn. Kathy Crump, Senior Agriculturist
Germplasm Development	Stillwater, OK Owen Merkle, Research Agronomist Vacant, Cytogeneticist, Res. Assoc. Cheryl Baker, Assistant Researcher Rita Veal, Biological Techncn.
Alternate Hosts	Stillwater, OK Dean Kindler, Research Entomologist Tim Springer, Agrl. Res. Techncn.
Biocontrol	Stillwater, OK David Reed, Research Entomologist Benjamin Puttler, Res. Entomologist, TDY Vacant, Insect Pathologist, Res. Assoc. Vacant, Biological Techncn.
	Behoust, France Ray Moore, Research Entomologist Tadeusz Poprawski, Res. Insect Pathologist Francis Gruber, Agrl. Asst., Entomol. Guy Mercadier, Pathology Techncn. Eva Rey, Laboratory Techncn.
	Brookings, SD Norman Elliott, Research Biologist Robert Kieckhefer, Research Entomologist
	Newark, DE Roger Fuester, Research Entomologist Lawrence Ertle, Entomologist Paul Schaefer, Research Entomologist
	Ithaca, NY Richard Humber, Microbiologist

<u>RWA/Host Interaction</u>	<u>Stillwater, OK</u> Robert Burton, Research Entomologist John Burd, Biological Techncn.
	<u>Brookings, SD</u> Robert Kieckhefer, Research Entomologist Walter Riedell, Res. Plant Physiol.
<u>Simulation Modeling</u>	<u>Brookings, SD</u> Norman Elliott, Research Biologist
<u>Biosystematics</u>	<u>Beltsville, MD</u> Manya Stoetzel, Research Entomologist

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